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PROVISIONAL SPECIFICATION FOR THE INVENTION ENTITLED:

Process for Separation, Deodorisation and Use of Biosolids

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This invention is best described in the following statement:

PROCESSES FOR SEPARATION, DEODORISATION AND USE OF BIOSOLIDS

Technical Field of the Invention

The invention relates to processes for treatment of waste water, for decreasing the
5 odour of odoriferous materials or for decreasing the propensity of such materials to
develop an odour over time, and to composting processes in which a compostable
material is mixed with a source of microorganisms.

Background of the Invention

Processes for the separation of solids of biological origin that are suspended in
10 wastewater are widely practised. The efficient separation of the solids from the water and
the disposal of the separated solids present difficulties, however.

The separation of solids from wastewater, especially the separation of sewage
sludge, is technically difficult because typically the solids are very finely divided and of
such a nature that at best with existing technologies sludges having a solids content in the
15 range of 10-12% by weight can be achieved. Such processes typically require
polyelectrolytes to be added to the water to assist the coagulation of the solids. However,
polyelectrolytes are expensive to use.

Furthermore, disposal or further treatment of the sludge separated in this way is
associated with difficulties. Existing technologies for processing of the sludge include
20 dewatering, extended aeration, anaerobic digestion and drying in lagoons. Anaerobic
digestion may produce a product which is difficult to dispose of because of its odour and
the fact that it may not be sterile. Similarly, dewatering procedures and drying in
lagoons, are costly and environmentally unsatisfactory because the sludge, during drying,
and storage tends to have an offensive smell.

25 Alternatively, the sludge may be used as a source of microorganisms for
composting by adding it to green waste or other similar degradable materials. However,
the composting process typically also produces disagreeable odours and in many
instances requires the purchase of significant amounts of green waste to permit all the
available sludge to be utilised. Furthermore, existing composting processes may not
30 develop sufficiently high temperatures to sterilise the resulting composted material,
rendering it unsuitable for sale or for use in various situations.

There is therefore a need for improved processes for the treatment of wastewater containing suspended solids, for the deodorisation of sewage sludge and other odoriferous materials, for decreasing the propensity of such materials to develop disagreeable odours over time, and for improved composting processes.

5 Surprisingly, the present inventors have found that these needs can at least partially be met by the use of a material derived from bauxite refinery residue that is commonly known as "red mud".

Summary of the Invention

10 In a first embodiment, the present invention provides a process for treating wastewater containing suspended solids comprising adding to the wastewater a treating substance in an amount sufficient to enhance at least one of (a) the settling rate of the solids, (b) the bulk density of the solids and (c) the filterability of the solids, said treating substance being selected from the group consisting of (i) bauxite refinery residue known as red mud, and (ii) red mud that has been at least partially reacted with calcium and/or
15 magnesium ions so as to have a reaction pH, when mixed with five times its weight of water, of less than 10.5.

In a second embodiment, the present invention provides a process for decreasing the odour of a material having an odour due to the presence of one or more sulphur-containing substances, comprising adding to said material a treating substance in an
20 amount effective to decrease the odour of the material, wherein the treating substance is selected from the group consisting of (i) bauxite refinery residue known as red mud, and (ii) red mud that has been at least partially reacted with calcium and/or magnesium ions so as to have a reaction pH, when mixed with five times its weight of water, of less than 10.5.

25 In a third embodiment, the present invention provides a process for decreasing the propensity of a material to develop an odour due to one or more sulphur-containing substances, comprising adding to said material a treating substance in an amount effective to inhibit the development of odour in the material, wherein the treating substance is selected from the group consisting of (i) bauxite refinery residue known as red mud, and
30 (ii) red mud that has been at least partially reacted with calcium and/or magnesium ions so as to have a reaction pH, when mixed with five times its weight of water, of less than 10.5.

In a fourth embodiment, the present invention provides a composting process in which a compostable material is mixed with an amount of a material containing

microorganisms and the microorganisms convert the compostable material to compost, wherein the mixture of compostable material and the material containing microorganisms further contains a treating substance selected from the group consisting of (i) bauxite refinery residue known as red mud, and (ii) red mud that has been at least partially reacted with calcium and/or magnesium ions so as to have a reaction pH, when mixed with five times its weight of water, of less than 10.5.

Detailed Description of the Invention

In the processes of the present invention, the treating substance is either the bauxite refinery residue known as "red mud", or "red mud" that has been at least partially reacted with calcium and/or magnesium ions so as to have a reaction pH, when mixed with 5 times its weight of water, of less than 10.5, typically in the range of 8.0 to 10.5. Processes for the reaction of red mud with a solution of calcium and/or magnesium ions are described in International Patent Application No. PCT/AU01/01383, the contents of which are incorporated herein in their entirety, or they may involve the reaction of red mud with sufficient quantity of seawater to decrease the reaction pH of the red mud to less than 10.5, typically in the range of 8.0 to 10.5. For example, it has been found that if an untreated red mud has a pH of about 13.5 and an alkalinity of about 20,000 mg/L, the addition of about 5 volumes of world average seawater will reduce the pH to between 9.0 and 9.5 and the alkalinity to about 300 mg/L.

As taught in International Patent Application No. PCT/AU01/01383, a process for reacting red mud with calcium and/or magnesium ions may comprise mixing red mud with an aqueous treating solution containing a base amount and a treating amount of calcium ions and a base amount and a treating amount of magnesium ions, for a time sufficient to bring the reaction pH of the red mud, when one part by weight is mixed with 5 parts by weight of distilled or deionised water, to less than 10.5. The base amounts of calcium and magnesium ions are 8 millimoles and 12 millimoles, respectively, per litre of the total volume of the treating solution and the red mud; the treating amount of calcium ions is at least 25 millimoles per mole of total alkalinity of the red mud expressed as calcium carbonate equivalent alkalinity and the treating amount of magnesium ions is at least 400 millimoles per mole of total alkalinity of the red mud expressed as calcium carbonate equivalent alkalinity. Suitable sources of calcium or magnesium ions include any soluble or partially soluble salts of calcium or magnesium, such as the chlorides, sulfates or nitrates of calcium and magnesium.

A further method by which the treating substance may be prepared comprises the steps of:

(a) contacting red mud with a water soluble salt of an alkaline earth metal, typically calcium or magnesium or a mixture of the two, so as to reduce at least one of the pH and alkalinity of the red mud; and

(b) contacting the red mud with an acid so as to reduce the pH of the red mud to less than 10.5.

Optionally, this process may further include the step of separating liquid phase from the red mud after step (a) and before step (b).

In step (a) of this process, the pH of the red mud is usually reduced to about 8.5 - 10, alternatively to about 8.5 - 9.5, alternatively to about 9 - 10, alternatively to about 9.5 - 10, preferably from about 9 - 9.5.

In step (a) of this process, the total alkalinity, expressed as calcium carbonate alkalinity, of the red mud may be reduced to about 200 mg/L - 1000 mg/L, alternatively to about 200 mg/L - 900 mg/L, alternatively to about 200 mg/L - 800 mg/L, alternatively to about 200 mg/L - 700 mg/L, alternatively to about 200 mg/L - 600 mg/L, alternatively to about 200 mg/L - 500 mg/L, alternatively to about 200 mg/L - 400 mg/L, alternatively to about 200 mg/L - 300 mg/L, alternatively to about 300 mg/L - 1000 mg/L, alternatively to about 400 mg/L - 1000 mg/L, alternatively to about 500 mg/L - 1000 mg/L, alternatively to about 600 mg/L - 1000 mg/L, alternatively to about 700 mg/L - 1000 mg/L, alternatively to about 800 mg/L - 1000 mg/L, alternatively to about 900 mg/L - 1000 mg/L, preferably less than 300 mg/L.

In step (b) of this process, the pH is typically reduced to less than about 9.5, preferably to less than about 9.0, and the total alkalinity, expressed as calcium carbonate equivalent alkalinity, is preferably be reduced to less than 200 mg/L.

In the process of the first embodiment, the solids may be sludge separated from wastewater such as sewage or industrial wastewater during conventional treatment processes, or they may be solids from any other source. Typically, the solids are insoluble or partially soluble materials of essentially biological origin that are contained as a suspension or dispersion in water. Usually, the solids will contain biologically active microorganisms.

The process of the first embodiment may be part of any water or sludge treatment process whether part of a conventional sewage treatment process or any other process which may involve the separation of solid waste from liquid waste streams.

The amount of treating substance added to the wastewater in the process of the first embodiment will be sufficient to result in an increased settling rate, bulk density and/or filterability of the solids present, compared to the same property of sludge obtainable by a similar process without the use of the treating substance.

5 Similarly, in the processes of the second and third embodiments, the amount of treating substance added to the material having an odour or having the propensity to develop an odour is an amount sufficient to at least improve the odour and/or to at least diminish the propensity of the material to develop an odour. In these embodiments of the invention, the material is typically, but not necessarily, sewage sludge or compost. Other
10 materials to which these processes are applicable include animal excrement, dredge spoil, garbage and the like.

In the processes of the second and third embodiments, the odour due to the presence of one or more sulfur-containing substances is usually the result of microbiological activity. That is, the odour is usually produced by microorganisms.

15 In the process of the first embodiment, the amount of treating substance used will typically be at least 5% by weight of the weight of solids present in the wastewater. It will be appreciated that the benefit of adding the treating substance is exhibited by any amount above the minimum effective amount, and so may be up to 100%, 150%, 200%, 250%, 300% or more by weight of the weight of solids present in the wastewater. The
20 minimum effective amount may depend on the amount of solids present and/or the presence of various dissolved species, and/or other additives that are added to the wastewater. For any given application, the minimum effective amount of treating substance to be added may be readily determined by routine experimentation, given the teaching herein. As an example, where the wastewater is sewage prior to clarification,
25 the amount of treating substance added will usually be in the range of about 10 - 100 mg/L or 10% to 50% by weight of the weight of solids present in the wastewater, even more usually about 50 mg/L or 25% by weight of the weight of the solids present in the wastewater.

Similarly, in the process of the second and third embodiments, the amount of
30 treating substance used will typically be at least 5% by weight of the material to be deodorised. Again, there is no particular benefit in adding more than the minimum effective amount, but the amount of treating substance added may be up to 100% by weight of the weight of material, or more. However, more usually the amount of treating substance added will be in the range of about 10% to 50% by weight of the weight of the

material, even more usually about 25% by weight of the weight of the material to be deodorised.

Although the bauxite refinery residue known as red mud may be used directly as the treating substance in the processes of the present invention, more usually the treating substance is red mud that has been at least partially reacted with calcium and/or magnesium ions so as to have a reaction pH, when mixed with five times its weight of water, of less than 10.5, typically between 8.0 and 10.5.

In one preferred form, the process of the first embodiment consists of a process for separating solids from wastewater in which a polyelectrolyte is added to the wastewater to at least partially flocculate the solids and then the solids are separated from the wastewater by filtration, wherein the treating substance is added to the wastewater before the polyelectrolyte is added.

The polyelectrolyte used in this form of the process of the first embodiment can be any polyelectrolyte known in the art to be useful for the separation of solids from wastewater. Examples of typical polyelectrolytes are polyacrylamides, hydrolysed polyacrylamides, polyacrylic acids, polymethacrylic acids, polyacrylic acid copolymers, various polyamines such as polyvinylamine, polyethylene amine, polyvinylpyridine, polyvinylpiperidine, polyvinylpyrrolidine and quaternized derivatives thereof, and the like.

Surprisingly, it has been found that by including the treating substance in the process of the first embodiment, various benefits are achieved, compared to the same process without the treating substance. The benefits include:

- where the treating substance is added to wastewater before a primary clarification step: the bulk density and filterability of the solids separated in the primary clarification are improved;
- where the treating substance is added to the wastewater in or after a primary clarification step: the bulk density, particulate nature and filterability of the solids precipitated from the wastewater is improved so as to reduce the amount of filter aid and polyelectrolyte flocculating agent required to dewater the solids; and
- the sludges produced by the process are stabilised with respect to the presence of odour or odour development, so as to facilitate environmentally acceptable disposal or further processing.

For example, typically, in existing processes the solids are produced from a wastewater clarification process in the form of sludge with a solids content of 0.5-1.0%. After dewatering the sludge in the presence of a polyelectrolyte in a prior art process,

whether by belt filtration, dissolved air flotation or other means, the solids content typically increases to 10-12%. The addition of 25% by weight, based on the weight of solids present, of the treating substance to the sludge, either as an aid to, or after, clarification, provides a cake with a solids content of 14-17%, and typically requires only
5 40-55% of the normal polyelectrolyte dose due to improved dewatering efficiency.

A filter aid and/or one or more other conventional water treatment additives may optionally be employed in the process of the first embodiment. A typical filter aid is diatomaceous earth. The treating substance may be added at the same time as, before or after other additives, depending on the nature of the additive. The treating substance may
10 be added at any stage in the wastewater treatment process. It may be added to untreated, fresh sewage (influent) or at any stage within a wastewater treatment plant. However, it is preferably added after primary sedimentation and clarification is completed and more preferably it is added to the discard biosolids liquor, after secondary sedimentation and clarification is completed.

15 In another preferred form of the process of the first embodiment, in which the wastewater contains dissolved phosphorus-containing compounds, an amount of at least one metal ion is added to the wastewater sufficient to at least partially precipitate a phosphorus-containing compound of the at least one metal, and the treating substance is dispersed in the water before adding the at least one metal ion. In this form of the
20 process, the solids may be separated along with the precipitated phosphorus-containing compound and separated from the treated water together.

In this form of the process of the first embodiment, the metal ion is typically at least one of iron, aluminium and calcium, still more typically iron, which may be ferric or ferrous iron or a mixture of the two. The amount added is typically not more than 1.5
25 times the stoichiometric amount required to react with the amount of dissolved phosphorus present, but an excess could be added if so desired. Suitably, the metal ion is added as a soluble salt of the metal such as a chloride, sulfate or the like. Optionally, the pH of the water may be adjusted, suitably to a pH in the range of about 6.5 to 7.5, between the addition of the treating substance and the addition of the one or more metal
30 ions.

This form of the process of the first embodiment is usually carried out on wastewater from which some solids have already been removed by a settling and clarification step. In this form of the process of the first embodiment, the amount of treating substance added to the wastewater will usually be about 1 g/L or more of water to
35 be treated, but will more usually be not more than about 0.5 g/L, still more usually not

more than about 0.3 g/L, even more usually up to about 0.25, 0.2, 0.15 or 0.1 g/L yet more usually up to about 50 mg/L. Typically, the amount of treating substance added will be about 50 mg/L.

In one form of the processes of the second and third embodiments, the material
5 having an odour or having the propensity to develop an odour may be sludge separated from a sewage treatment process. In this form of the processes of the second and third embodiments, the addition of the treating substance to the sludge may be achieved by adding the treating substance to the sludge after it has been removed from the bulk of the wastewater with which it is associated. Alternatively, and more preferably, the treating
10 substance may be added to the wastewater prior to the separation of the sludge from the water. As in the process of the first embodiment, optionally other conventional additives for flocculating and/or coagulating the solids present and/or for precipitating dissolved species present (such as phosphorus compounds) may be added to the wastewater. Such conventionally used additives include polyelectrolytes as exemplified above, filter aids
15 and metal ions such as iron and/or aluminium ions.

The processes of the second and third embodiments provide significant advantages over prior art processes in which the treating substance is not used, in that the materials treated by the processes of the second and third embodiments have a reduced odour and do not develop a disagreeable odour over time, or during further processing, to the same
20 degree as the materials without the treating substance added to them. Typically, the odour of materials treated by the process of the third embodiment does not change appreciably during storage of the treated materials over a period of days or even weeks.

Similarly, in a composting process of the fourth embodiment, the odour of the composting material is typically substantially reduced during the composting process, and
25 the development of odour during the composting process and subsequent storage of the compost is substantially reduced, typically substantially eliminated.

In addition to the advantages of the process of the first to third embodiments as described above, sludges and other solids or treated materials obtained by the processes of the first to third embodiments have an increased ability to retain metal ions. Thus, if a
30 sludge contains toxic metals that would tend to leach out over time, the addition of the treating substance to it will reduce the propensity of the metals to be leached out, typically to the point where the sludge complies with the Toxicity Characteristic Leaching Procedure (TCLP; USEPA method 1311). Thus, untreated sludges containing toxic metals obtained without the use of the treating substance may not be capable of being
35 discharged to the environment, whereas sludges obtained by the processes of the present

invention which pass the TCLP test, may not be precluded from being discharged to the environment on the basis of their toxic metals content.

In the process of the fourth embodiment, the treating substance may be added to the compostable material together with, or separately from, the material containing
5 microorganisms. Preferably, the material containing microorganisms and the treating substance are added together. More preferably, the material containing microorganisms and the treating substance are added together in the form of sludge separated from sewage by a process of the first embodiment. Still more preferably, the mixture of sludge and treating substance is produced by combining the underflow from a clarification step in a
10 sewage treatment process with solids that have been separated from the overflow of the clarification step using a form of the process of the first embodiment in which one or more metal ions is added to the overflow after the treating substance is added to it, in order to precipitate insoluble phosphorus-containing compounds of the one or more metals. It will be appreciated that in this form of the process of the fourth embodiment,
15 the phosphorus present in the mixture of sludge and treating substance added to the compostable material can be beneficial to the composting process and/or can be beneficial if the compost produced by the process of the fourth embodiment is used as a soil supplement or fertiliser. In this form of the process of the fourth embodiment the amount of treating substance added to the overflow will typically be equal to about 25% by
20 weight of the total solids present in the underflow and the overflow.

The quantity of treating substance to be used in a process of the fourth embodiment of the invention will typically be in the range of about 2% to 20% by weight of the compostable material. Greater amounts may be employed but there is no particular benefit from doing so. Usually, the amount of treating substance is in the range of about
25 5-10% by weight, more usually about 7% by weight, of the weight of the compostable material. In a preferred form of the process of the invention, the treating substance is added together with the biosolids, in a ratio of about 1 part by weight of the treating substance to about 3 parts by weight of the biosolids.

In the process of the fourth embodiment, the material containing microorganisms
30 may, as described above, be sewage sludge obtained by a process of the first embodiment, or it may be any other convenient source of microorganisms. Examples of such sources include animal biosolids such as manure; dredge spoil; rotting garbage; worm casts; leaf mould; humus and active loam.

Apart from odour reduction, which is a significant benefit of the process of the present invention, the process of the fourth embodiment provides other advantages over prior art composting processes in which none of the treating substance is present.

For example, the rate of composting of the biomass is accelerated in the process of the fourth embodiment, and thereby the temperature of the composting mass is increased and the pathogen content of the composted mass is substantially reduced. This presents commercial benefits through increased throughput in commercial composting facilities and improved saleability of the compost produced because of its lower pathogen content. In one known composting operation, dewatered sludge ("biocake") is mixed in a 1:4 ratio with imported green waste using a front-end loader. It is then composted in windrows for 11-14 weeks, turned regularly to aerate the composting mass, and the final product used for various agricultural and horticultural purposes. In the process of the fourth embodiment, the time taken for completion of the composting process is typically reduced to 6 - 8 weeks, as judged by the pH reaching 7 - 8 and the compost internal temperature falling to less than 50°C.

The process of the fourth embodiment is not limited in application to such a process, however, and may be employed with advantage in all composting processes. Thus, the process of the fourth embodiment is applicable to all composting processes that are known in the art, regardless of the materials handling technology involved, to give accelerated composting rates.

Additionally, it has been found that in the process of the fourth embodiment, the amount of compostable material that needs to be added to the material containing microorganisms in order to obtain a suitable compost product is substantially reduced. In situations where the compostable material must be purchased, this provides a substantial benefit. In a process of the fourth embodiment in which the material containing microorganisms is sewage sludge, the ratio of amounts of sludge to compostable material is typically about 1:2.5 by weight, whereas in the absence of the treating substance, the ratio is typically about 1:4 by weight.

Furthermore, it has been found that the compost obtained by the process of the fourth embodiment typically has an improved texture, compared to the compost of the prior art process, and improved water-retaining ability.

The treating substance for use in the processes of the invention is preferably a material obtainable from Virotec International Pty Ltd, of Sanctuary Cove, Queensland, Australia, under the trademark Bauxsol.

Examples

The following Examples are included to illustrate the invention, but they are not intended to place any limitation on the scope of the invention. In each of the Examples, the treating substance used was Bauxsol™ additive.

5 Example 1 Biosolids filtration trials

In this and subsequent trials, the amount of Bauxsol™ added was calculated to be 25% of the total biosolids dry weight in the sludge or waste water source.

A. *Laboratory-scale investigation into treatment of biosolids sludge resulted in:*

- a marked increase in percent solids of biocake of between 3-5%;
- 10 • a reduction of 60% of polyelectrolyte required;
- a dramatic reduction in odour from both treated liquor water and biocake.

B. *Pilot plant testing on raw sludge, and biosolids sludge from a municipal sewage treatment plant.*

To 1000L of secondary-treated sewage wastewater containing 5mg/L phosphorus as
15 P, and 20mg/L suspended biosolids, 50g of Bauxsol was added, followed by 50g ferric chloride. The treated water contained less than 0.1mg/L P and 2mg/L suspended solids. The phosphate-rich sediment was harvested by decantation and collection of slurry (3L volume). This sediment slurry was then added to 30L of discard biosolids liquor from the same treatment plant, with a solids content of 0.6%. To the mixture, 180mL of
20 polyelectrolyte was added (44% of the normal addition rate) and filtered on a belt filter to produce treated biocake with a solids content of 17%. The proportion of Bauxsol thus added was 25% of the combined biosolids from the discard liquor and the phosphorus precipitation step.

Example 2 Biosolids odour and storage trials

25 Both treated and untreated biocake were stored in open and closed containers for several weeks and their odours compared at regular intervals. By "treated biocake" is meant biocake which had been mixed with 25% by weight, on a dry solids basis, of Bauxsol™ additive. Qualitative odour levels were determined subjectively by 3 observers.

- 30 • For treated and untreated biocake stored in sealed containers, the odour of the untreated biosolids was found to be strongly objectionable, however odour from the treated biosolids was assessed as "detectable, but not objectionable". Visible differences of colour and texture between the two samples were also noted.

- The biocake stored in open containers exhibited the greatest differences in odour. Untreated biocake developed a very strong, objectionable, "rotting sewage" odour whereas treated biocake odour was described as like "moist earth" with no objections from observers. Even after 3 weeks, no objectionable odours were detected from treated biosolids.
- The treated biocake has been shown to meet the New South Wales EPA guidelines for disposal and re-use in agriculture.

Example 3 Large scale bulk density and filterability trials

Two 1000L plastic containers were used to dispense Bauxsol™ at a rate equivalent to 25% of the dry weight of biosolids into the biosolids stream prior to a belt press. The addition rate of polyelectrolyte prior to filtration was varied in the range 1.0 - 13.7 mL/L (the typical rate for this plant is 13.7 mL/L) and the treated biosolids were de-watered on the belt press, collected and removed for composting trials (see Example 4). The belt speed and tension of the gravity belt were adjusted for optimum use.

At 5.0 mL/L of polyelectrolyte, dewatering appeared to be identical to that achieved in the absence of Bauxsol™ but with 13.7mL/L of polyelectrolyte instead of 5mL/L. At 6.0 mL/L of polyelectrolyte, the maximum solids content (14.2%) of the biocake was achieved. At 7.25 mL/L (53% of untreated operating dose) the texture of the biocake was subjectively judged to be optimum.

The resultant biocake had a different texture (being more spongy than biocake produced in the absence of Bauxsol™) and had no objectionable odours. The test was continued for the entire day with a total of 415 kilolitres of biosolids liquor being processed. The biocake percent solids was calculated to be 14%, compared with untreated biocake solids at 10.5%.

In another similar test the treated biocake "stood up" to an angle of approximately 50° in the truck indicating an advantageously higher packing density. In this second test a total of 494 kilolitres of biosolids liquor were treated with resultant percentage solids of 14.2%.

Example 4 Composting trials

At the facility where the trials were carried out the biocake is normally transferred by truck from the municipal treatment plant and then mixed in a 1:4 ratio by weight with imported green waste using a front-end loader. It is then composted in windrows for 11-14 weeks being turned regularly to aid in composting, and the final product is used in council parklands.

For the trial, the biocake from Example 3 was unloaded into two heaps and then mixed with green waste in 1:1 and 1:3 ratios. The piles were turned regularly and observations were recorded by the loader operator.

5 The 1:1 and 1:3 piles both stood up well and did not sag or collapse. After six days it was agreed that the 1:1 pile was not composting efficiently, so more green waste was added to bring it to a 1:2.25 blend. Sufficiently high temperatures were subsequently achieved within 24 hours. Large clouds of steam were released from the two piles, during movement by heavy plant equipment. Temperatures were determined utilising standard thermocouple probes during the composting process and were shown to exceed 75°C with
10 an average temperature in excess of 65°C. No leaching from either pile was evident even after rain events, and minimal odour was detected throughout the process.

After 10 days the 1:2.25 (formerly 1:1) pile was deemed to be slowing down so it was dosed with dry sawdust to increase the ratio of biocake to green waste to 1:2.5 which then raised the temperature to 49°C and the pile was allowed to continue composting.

15 After 2 weeks both piles were in excess of 60°C with no unpleasant odour. The colour of the two piles was a dark chocolate brown.

After 7 weeks the treated biosolids/green waste mix was pH 7 - 8 and internal temperature average of 50°C or less and the composting process was deemed to be complete and the product ready for use.

20 The trial demonstrated that, in the presence of Bauxsol™

- the rate of composting was increased markedly and reduced the production time from 11 - 14 weeks to 7 weeks;
- the temperature of the composting mass exceeded 75°C within 24 hours and averaged 65°C (this temperature exceeds the normal pasteurising temperature
25 required destroy pathogens);
- the ratio of biocake to carbonaceous waste (green waste) required to produce a satisfactory product was decreased from 1:4 to 1:2.25.

Example 5 Compost odour and storage trials

30 Five hundred litres of biosolids liquor was placed in a plastic container along with Bauxsol™ additive in an amount of 25% by weight of the dry weight of solids, and half the usual amount of polyelectrolyte. The solution was stirred and let stand for 30 minutes.

The treated biosolids were placed onto a belt press and de-watered. The resultant biocake was collected and placed into two 200litre black plastic drums with sealable lids, along with green waste from the local public tip in 1:1 and 1:3 ratios.

An identical experiment was conducted using untreated biosolids (that is, with no Bauxsol added) for standardisation and control comparisons.

The drums were all left in a sunny position, watered, rolled and subjectively tested for odour daily over a one-month period.

The drums containing treated biocake consistently exhibited low odour compared with the untreated biosolids drums and composted to a smaller volume than the untreated material. After three months none of the treated biosolids composting trials exhibited any offensive odours or leachate.

Example 6 Compost water retention

The water retention capability of the compost produced from Bauxsol-treated and untreated biosolids and a proprietary potting mix was determined according to the following:

1000g of each material was weighed, spread thinly onto a 250mm square drying tray and subjected to oven drying at 105°C until constant weight was attained. Results are presented in the Table 1.

Table 1

Material	Initial Weight (g)	Final Weight (g)	% Moisture	Time to Constant Weight (hrs)
Potting Mix	1000	860	14	5
Untreated Biosolids	1000	640	36	20
Treated Biosolids	1000	630	37	60

The potting mix material contained visible coarse sand material, was very friable and separated easily, thus allowing for rapid loss of water under the drying conditions. The compost from untreated biosolids was coarse compared to the compost from treated biosolids, which appeared as fine-grained, densely-packed material.

The compost produced from the Bauxsol-treated biosolids retained moisture under severe drying conditions for 3 times longer than untreated compost and 12 times longer than the proprietary potting mix.

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- ☒ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☒ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☒ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
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